

Write your name here

Surname

Other names

Pearson Edexcel
Level 1/Level 2 GCSE (9-1)

Centre Number

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Candidate Number

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Mathematics

Paper 3 (Calculator)

Higher Tier

Tuesday 12 June 2018 – Morning

Time: 1 hour 30 minutes

Paper Reference

1MA1/3H

You must have: Ruler graduated in centimetres and millimetres, protractor, pair of compasses, pen, HB pencil, eraser, calculator. Tracing paper may be used.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You must **show all your working**.
- Diagrams are **NOT** accurately drawn, unless otherwise indicated.
- **Calculators may be used.**
- If your calculator does not have a π button, take the value of π to be 3.142 unless the question instructs otherwise.



Information

- The total mark for this paper is 80
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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Pearson

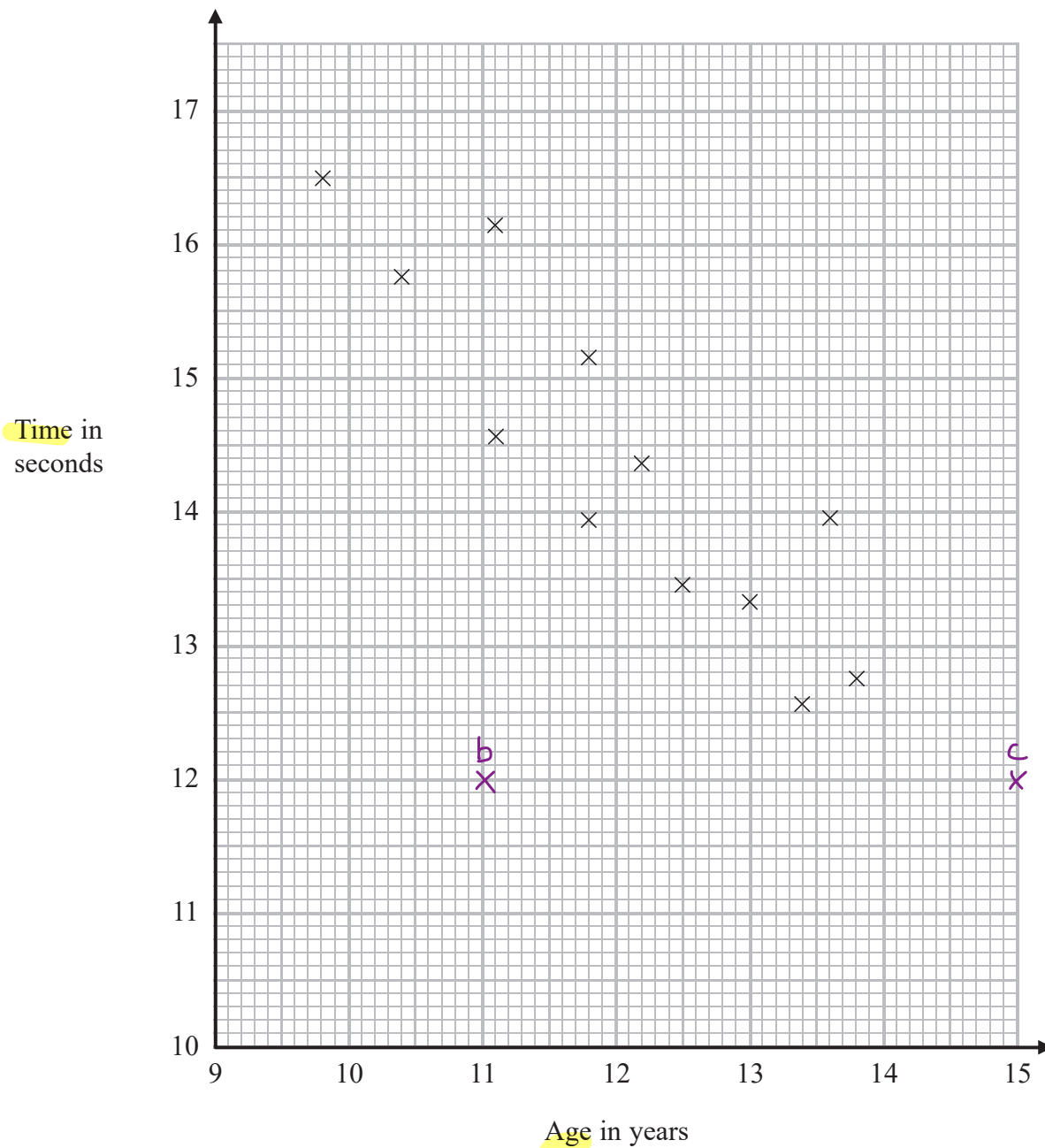
Answer ALL questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1 The scatter diagram shows information about 12 girls.

It shows the age of each girl and the best time she takes to run 100 metres.



(a) Write down the type of correlation.

General trend = As age increases, time decreases
 Line of best fit has a negative gradient

Negative

(1)

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Kristina is 11 years old.
Her best time to run 100 metres is 12 seconds.

doesn't fit trend

The point representing this information would be an outlier on the scatter diagram.

(b) Explain why.

It is not in line with the trend of the other points

(1)

Debbie is 15 years old.
Debbie says,

Extrapolation → extending graph beyond plotted points is unreliable as we can't be sure that the trend will continue

"The scatter diagram shows I should take less than 12 seconds to run 100 metres."

(c) Comment on what Debbie says.

The point would be outside of the range of the scatter diagram

(1)

(Total for Question 19 is 3 marks)

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2 Expand and simplify

$$5(p + 3) - 2(1 - 2p)$$

$$((5 \times p) + (5 \times 3)) + ((-2 \times 1) + (-2 \times -2p))$$

$$= (5p + 15) + (-2 + 4p) \quad \text{① Expanding 1 bracket}$$

$$= (5p + 4p) + (15 - 2)$$

$$= 9p + 13 \quad \leftarrow (13 \text{ is prime})$$

9 and 13 have no common factors, so this can't be simplified further.

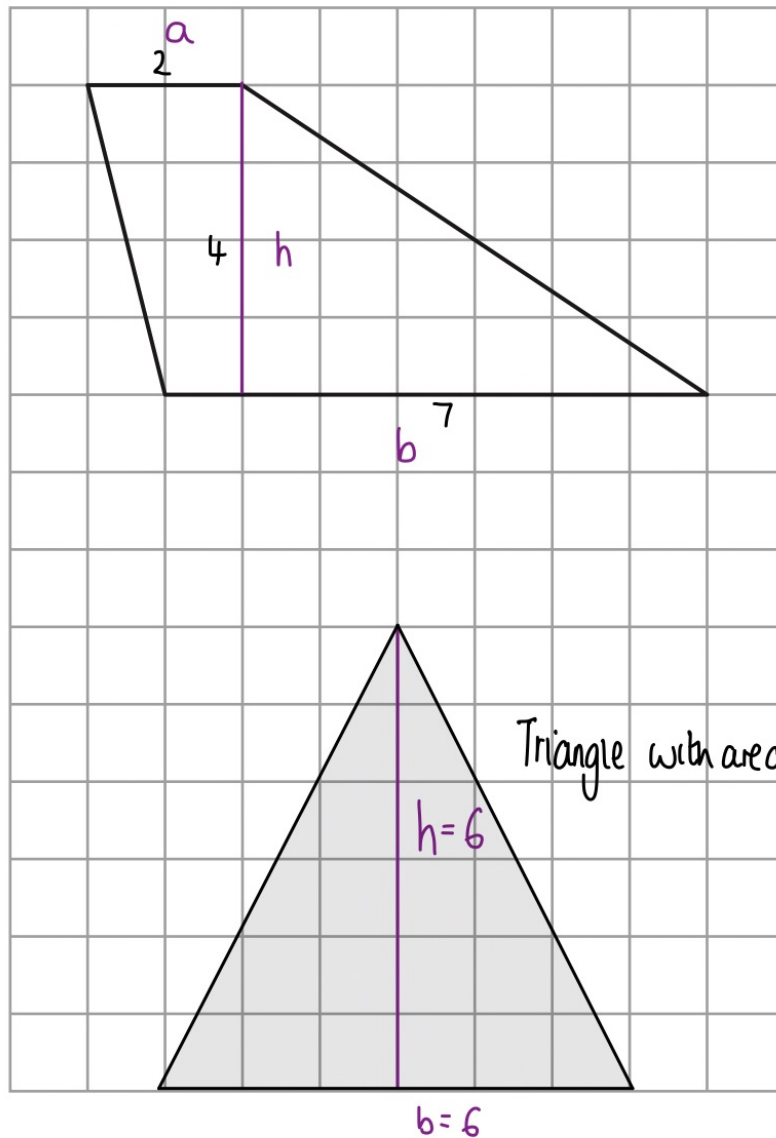
$$9p + 13 \quad \text{①}$$

(Total for Question 2 is 2 marks)

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3 Here is a trapezium drawn on a centimetre grid.



On the grid, draw a triangle equal in area to this trapezium.

$$\begin{aligned}
 \text{Area of Trapezium} &= \frac{1}{2} (a+b) \times h \quad \leftarrow \begin{array}{l} \text{sum of parallel sides} \\ \text{height between them} \end{array} \\
 &= \frac{1}{2} (2+7) \times 4 \\
 &= 18 \text{ cm}^2 \quad \textcircled{1}
 \end{aligned}$$

$$\begin{aligned}
 \text{Area of Triangle} &= 18 = \frac{1}{2} bh \\
 bh &= 36
 \end{aligned}$$

The base and height must multiply to get 36
= a factor pair of 36

9 and 4
or 6 and 6

If $b=6$ and $h=6$

(Total for Question 3 is 2 marks)

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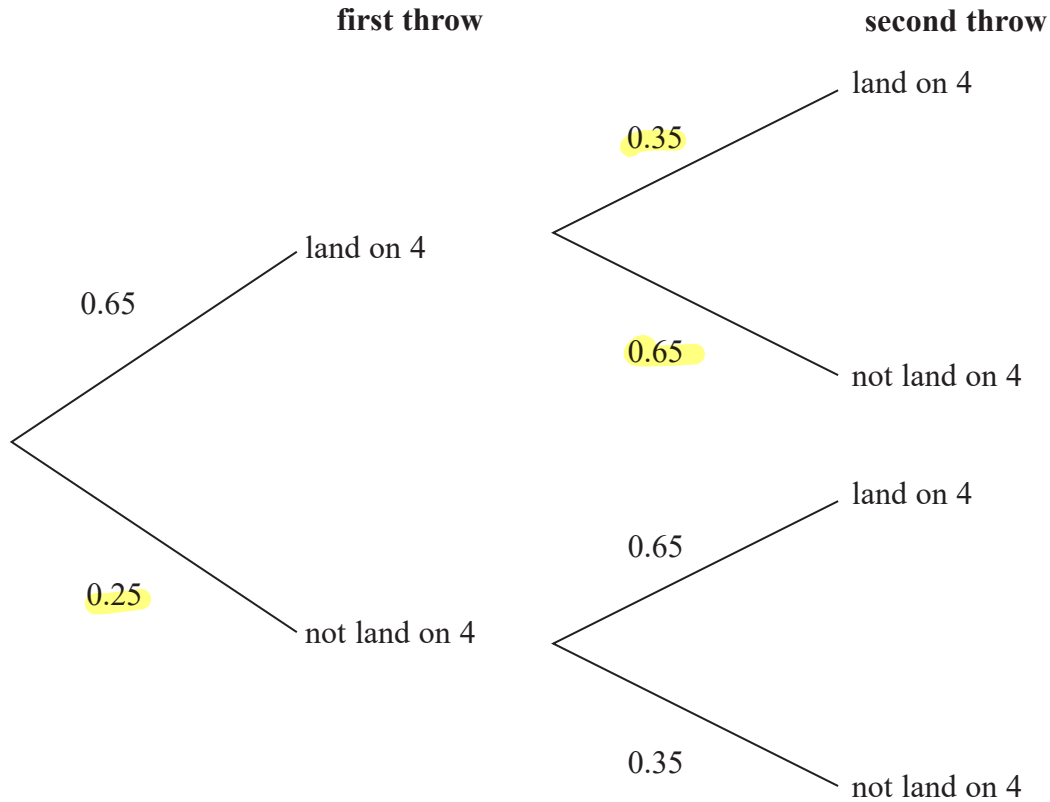
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- 4 When a **biased 6-sided dice** is thrown **once**, the probability that it will land on **4** is **0.65**. The biased dice is thrown twice.

Amir draws this probability tree diagram.
The diagram is **not** correct.



Write down **two** things that are wrong with the probability tree diagram.

- Probabilities should sum to 1
0.25 should be 0.35 (1)
- For the second throw, the probability it lands on a 4 should still be 0.65
(the top 0.35 and 0.65 should be swapped) (1)

(Total for Question 4 is 2 marks)

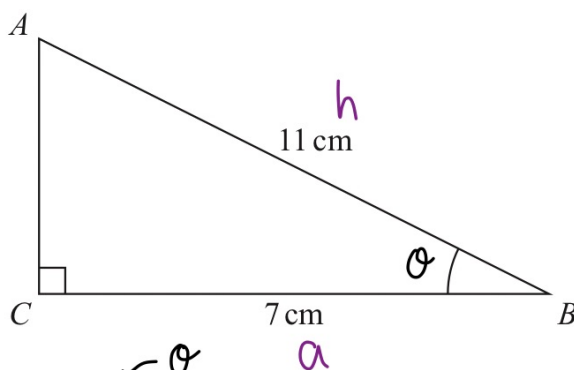


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5 *ABC* is a right-angled triangle.



- (a) Work out the size of angle *ABC*.
Give your answer correct to 1 decimal place.

SOH (CAH) TOA

We need to use cos as we have the length of the adjacent and hypotenuse

$$\cos \theta = \frac{a}{h} = \frac{7}{11}$$

$$\theta = \cos^{-1}\left(\frac{7}{11}\right)$$

$$\theta = 50.4788^\circ$$

$$\theta = 50.5^\circ \text{ to 1 dp}$$

50.5

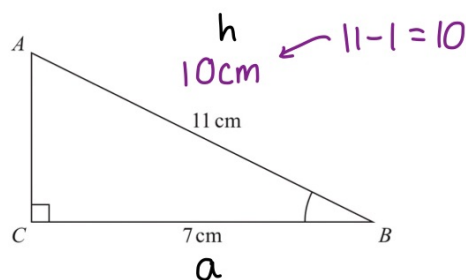
(2)

The length of the side *AB* is reduced by 1 cm.

The length of the side *BC* is still 7 cm.

Angle *ACB* is still 90°

- (b) Will the value of $\cos ABC$ increase or decrease?
You must give a reason for your answer.



$$\cos ABC = \frac{a}{h} = \frac{7}{10}$$

$\frac{7}{10}$ is greater than $\frac{7}{11}$, so $\cos ABC$ has increased

(1)

(Total for Question 5 is 3 marks)

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6 There are some counters in a bag.
The counters are red or white or blue or yellow.

Bob is going to take at random a counter from the bag.

The table shows each of the probabilities that the counter will be blue or will be yellow.

Colour	red	white	blue	yellow
Probability	$2x$	x	0.45	0.25

There are 18 blue counters in the bag.

The probability that the counter Bob takes will be red is twice the probability that the counter will be white.

(a) Work out the number of red counters in the bag.

Probabilities sum to 1 :

$$2x + x + 0.45 + 0.25 = 1$$

$$3x = 0.3 \quad (1)$$

$$x = 0.1$$

$$2x = P(\text{Red}) = 0.2 \quad (1)$$

$P(\text{Blue}) = 0.45$

$0.45t = 18$ ← total counters

$t = \frac{18}{0.45} = 40$ ← number of blue counters

counters (1)

Number of red counters :

$$40 \times 0.2 = 8$$

$$\frac{8}{(4)}$$

A marble is going to be taken at random from a box of marbles.

The probability that the marble will be silver is 0.5 $\frac{1}{2}t$ must be a whole number

There must be an even number of marbles in the box.

(b) Explain why.

0.5 multiplied by an odd number will never be a whole number and we can not have half a marble. For half of a number to be an integer, the number must be even. (1)

(Total for Question 6 is 5 marks)



7 **Solve** $\frac{5-x}{2} = 2x-7$ (find x)

We need to isolate the x terms

$$\times 2 \left(\begin{array}{l} \frac{5-x}{2} = 2x-7 \\ 5-x = 2(2x-7) \end{array} \right) \times 2$$

Do the same to both sides of the equals sign

$$+x \left(\begin{array}{l} 5-x = 4x-14 \\ 5 = 5x-14 \end{array} \right) +x$$

$$+14 \left(\begin{array}{l} 19 = 5x \\ 19 = 5x \end{array} \right) +14$$

$$\div 5 \left(\begin{array}{l} \frac{19}{5} = x \\ \frac{19}{5} = x \end{array} \right) \div 5$$

$$x = \frac{19}{5}$$

(Total for Question 7 is 3 marks)

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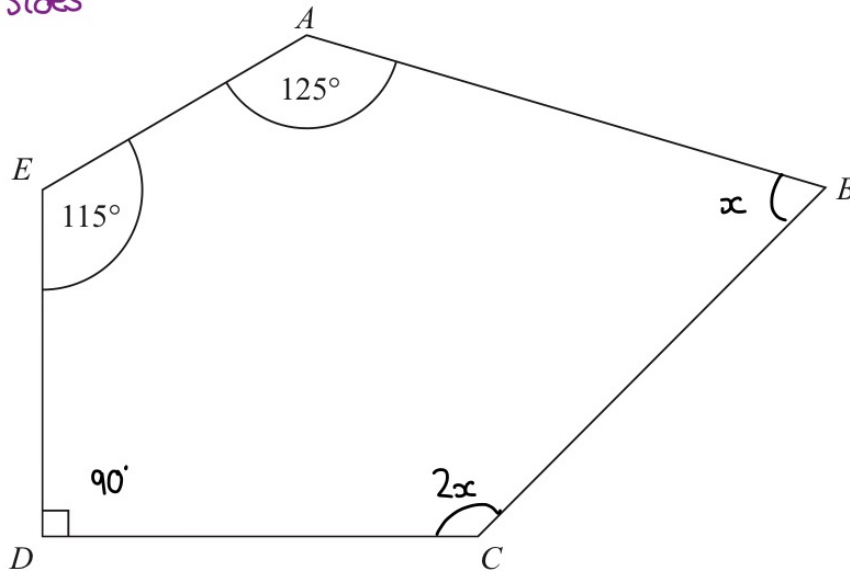
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8 $ABCDE$ is a pentagon.

5 sides



Angle $BCD = 2 \times$ angle ABC

Work out the size of angle BCD .
You must show all your working.

$$\text{Let } \angle ABC = x \quad \therefore \angle BCD = 2x$$

Sum of interior angles of a pentagon:

$$\begin{aligned} (n-2) \times 180 &= (5-2) \times 180 \quad \textcircled{1} \\ &= 180 \times 3 \\ &= 540^\circ \quad \textcircled{1} \end{aligned}$$

Setting up an equation in x :

$$\begin{aligned} x + 2x + 90 + 115 + 125 &= 540 \quad \textcircled{1} \\ 3x &= 210 \quad \textcircled{1} \\ x &= 70^\circ \end{aligned}$$

$$\angle BCD = 2x = 2 \times 70 = 140^\circ$$

140 $\textcircled{1}$ °

(Total for Question 8 is 5 marks)



$$9 \quad T = \sqrt{\frac{w}{d^3}}$$

$$\left. \begin{array}{l} w = 5.6 \times 10^{-5} \\ d = 1.4 \times 10^{-4} \end{array} \right\} \text{ in standard form}$$

(a) Work out the value of T .

Give your answer in standard form correct to 3 significant figures.

$$a \times 10^b \quad \text{where } 1 \leq a < 10$$

$$\begin{aligned} T &= \sqrt{\frac{5.6 \times 10^{-5}}{(1.4 \times 10^{-4})^3}} = 4517.53... \quad \textcircled{1} \\ &= 4520 \text{ to 3SF} \\ &= 4.52 \times 10^3 \\ & \quad 1 \leq 4.52 < 10 \end{aligned}$$

$$T = 4.52 \times 10^3 \quad \textcircled{1}$$

(2)

w is increased by 10% ← Scale factor of 1.1

d is increased by 5% ← Scale factor of 1.05

Lottie says,

“The value of T will increase because both w and d are increased.”

(b) Lottie is wrong.

Explain why.

Calculating the scale factor by which T has been multiplied:

$$= \sqrt{\frac{1.1}{1.05^3}} = 0.974... \quad \textcircled{1}$$

$$0.97 < 1$$

The value of the scale factor by which T is multiplied (to calculate its new value) is less than 1, so there is a decrease in T . $\textcircled{1}$

(2)

(Total for Question 9 is 4 marks)

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10 Here are three lamps.

lamp A

lamp B

lamp C



Lamp A flashes every 20 seconds.

Lamp B flashes every 45 seconds.

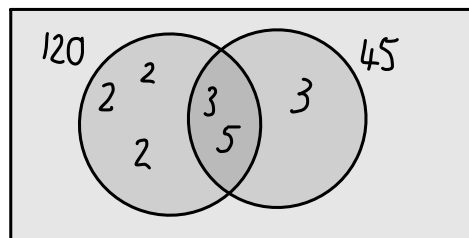
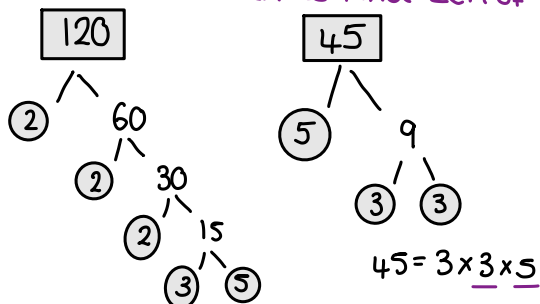
Lamp C flashes every 120 seconds.

120 is a multiple of 20, so every time C flashes, A will too

The three lamps start flashing at the same time.

How many times in one hour will the three lamps flash at the same time?

Prime Factorisation to find LCM of 120, 45 and 20.



$120 = 2 \times 2 \times 2 \times 3 \times 5$ ①

multiply every value in the venn diagram.

Lowest common multiple (LCM) = $2 \times 2 \times 2 \times 3 \times 5 \times 3 = 360$ ①

1 hour = $60 \times 60 = 3600$ seconds

$3600 \div 360 = 10$ times

10 ①

(Total for Question 10 is 3 marks)

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11 In 2003, Jerry bought a house.

(B) In 2007, Jerry sold the house to Mia.
He made a profit of 20%

(A) In 2012, Mia sold the house for £162 000.
She made a loss of 10%

Work backwards
through the information

Work out how much Jerry paid for the house in 2003

Using A: $M = \text{price Mia (2007) bought the house for}$
 $M \times 0.9 = \text{£162 000}$
 10% loss = 90% of the original value (multiplier of 0.9)

$$M = 162\,000 \div 0.9$$

$$M = \text{£180 000} \quad (1)$$

J = price Jerry bought the house for in 2003

$$J \times 1.2 = 180\,000$$

$$J = 180\,000 \div 1.2 \quad (1)$$

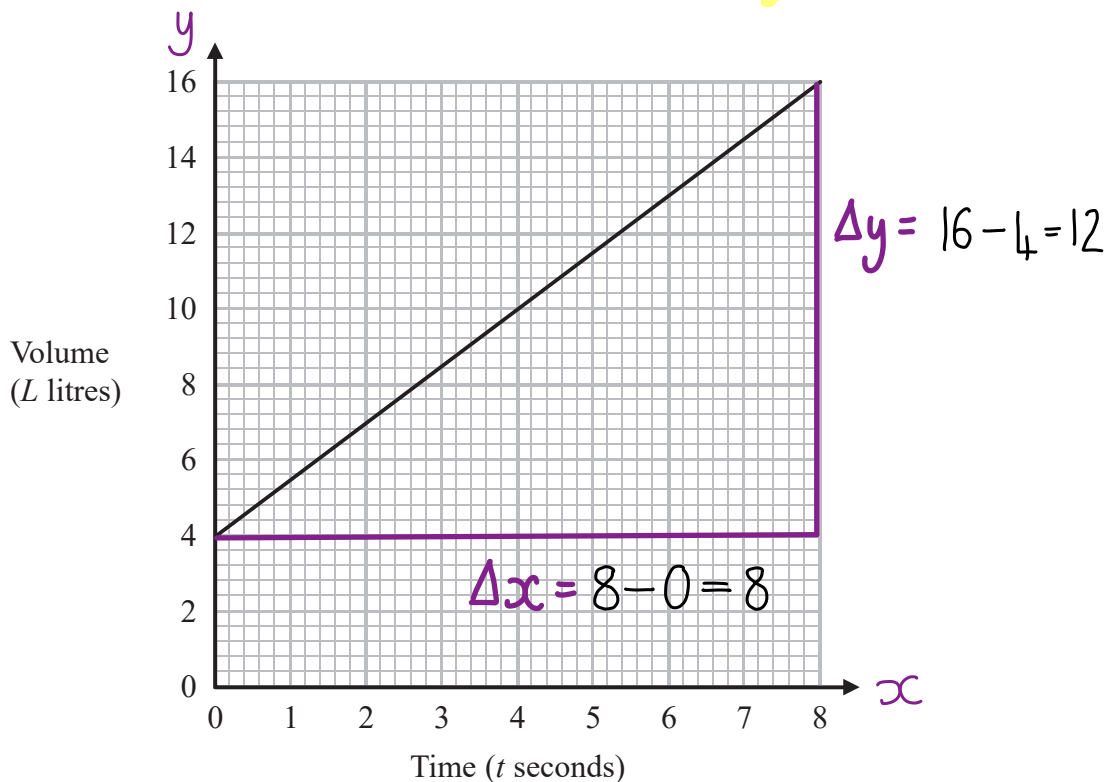
$$= \text{£150 000}$$

£ 150 000 (1)

(Total for Question 11 is 3 marks)



12 The graph shows the volume of liquid (L litres) in a container at time t seconds.



(a) Find the gradient of the graph.

$$m = \frac{\Delta y}{\Delta x} = \frac{12}{8} = 1.5$$

1.5 (1)
.....
(2)

(b) Explain what this gradient represents.

The rate at which the container fills (1)

(or The change in the number of litres per second.)

(1)

The graph intersects the volume axis at $L = 4$

(c) Explain what this intercept represents. $L = 4$ when $t = 0$

The number of litres in the container when $t = 0$ (1)

↖ initial number of litres.

(1)

(Total for Question 12 is 4 marks)

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13 Here are two **similar** solid shapes.



surface area of shape **A** : surface area of shape **B** = 3 : 4

The volume of shape **B** is 10 cm^3

Work out the volume of shape **A**.

Give your answer correct to 3 significant figures.

Surface Area Ratio:

$$\begin{aligned} A : B \\ 3 : 4 \end{aligned}$$

Length Ratio = $\sqrt{3} : \sqrt{4}$
 $\sqrt{3} : 2$
 $\div \sqrt{3} \left(\begin{array}{l} \textcircled{1} \\ \div \sqrt{3} \end{array} \right)$
 $1 : 1.1547\dots$

Volume Ratio =

$$\begin{aligned} 1^3 : 1.1547\dots^3 \\ 1 : 1.5396\dots \\ \times x \left(\begin{array}{l} \times x \\ \text{volume of B} \end{array} \right) \\ x : 10 \end{aligned}$$

$$x = \frac{10}{1.5396\dots} = 6.495\dots \textcircled{1} = 6.50 \text{ to 3 SF} \quad \dots\dots\dots 6.50 \textcircled{1} \dots\dots\dots \text{cm}^3$$

(Total for Question 13 is 3 marks)

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- 14 There are 16 hockey teams in a league.
Each team played two matches against each of the other teams.

Work out the total number of matches played.

Each team plays 15 other teams twice

A vs B is the same as B vs A, so should only be included once
Therefore the final answer should be divided by 2 to account for duplicates.

$$\begin{array}{l}
 \text{Number of} \\
 \text{teams}
 \end{array}
 \times
 \begin{array}{l}
 \text{(matches)} \\
 \text{Number of} \\
 \text{other teams}
 \end{array}
 \times
 \begin{array}{l}
 \text{"twice"} \\
 2
 \end{array}
 = 480$$

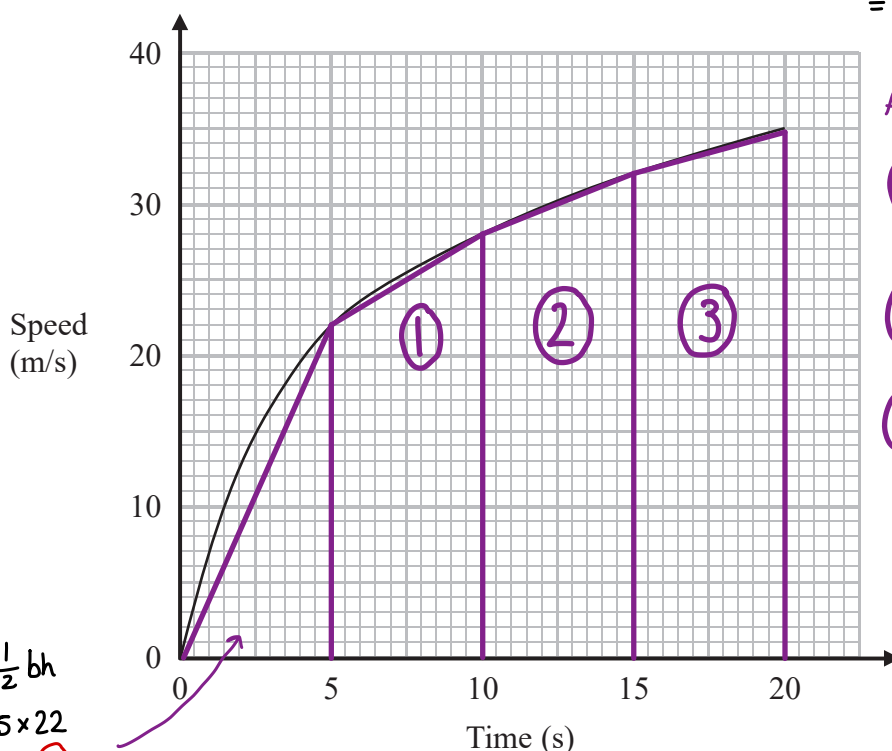
$$480 \div 2 = 240$$

.....240

(Total for Question 14 is 2 marks)



15 The graph shows the speed of a car, in metres per second, during the first 20 seconds of a journey.



$d = S \times t$
 $= \text{AREA under curve}$

Area of trapezium
 $A = \frac{1}{2}(a+b)h$

① $\frac{1}{2}(22+28) \times 5$
 $= 125$

② $\frac{1}{2}(28+32) \times 5$
 $= 150$

③ $\frac{1}{2}(32+35) \times 5$
 $= 167.5$

$\Delta \text{ area} = \frac{1}{2}bh$
 $= \frac{1}{2} \times 5 \times 22$
 $= 55$ ①

(a) Work out an estimate for the distance the car travelled in the first 20 seconds. Use 4 strips of equal width.

Sum of areas:
 $55 + 125 + 150 + 167.5 = 497.5$ ①

..... 497.5 ① metres
 (3)



(b) Is your answer to part (a) an underestimate or an overestimate of the actual distance the car travelled in the first 20 seconds?

Give a reason for your answer.

Underestimate - There are parts of the area below the graph
which are not included (1)

(1)

(Total for Question 15 is 4 marks)

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16 The n th term of a sequence is given by $an^2 + bn$ where a and b are integers.

The 2nd term of the sequence is -2

The 4th term of the sequence is 12

$U_n = an^2 + bn$

(a) Find the 6th term of the sequence.

2nd Term

$$U_2 = (a \times 2^2) + (b \times 2)$$

$$U_2 = (4a + 2b = -2) \quad \textcircled{1}$$

4th Term

$$U_4 = (a \times 4^2) + (b \times 4)$$

$$= (16a + 4b = 12) \quad \textcircled{2}$$

$$8a + 4b = -4 \quad \textcircled{3}$$

Solving $\textcircled{2}$ and $\textcircled{3}$ simultaneously:

$$\begin{array}{r} 16a + 4b = 12 \quad \textcircled{2} - \textcircled{3} \\ - 8a + 4b = -4 \quad \textcircled{1} \\ \hline \end{array}$$

$$8a + 0 = 12 - (-4)$$

$$8a = 16$$

$$a = 2$$

Subbing back into $\textcircled{1}$

$$4a + 2b = -2$$

$$(4 \times 2) + 2b = -2$$

$$8 + 2b = -2$$

$$2b = -10$$

$$b = -5 \quad \textcircled{1}$$

$$U_n = 2n^2 - 5n$$

$$U_6 = (2 \times 6^2) - (5 \times 6)$$

$$= 2 \times 36 - 30$$

$$= 72 - 30$$

$$= 42$$

$$\frac{42 \quad \textcircled{1}}{(4)}$$

Here are the first five terms of a different quadratic sequence.

n	1	2	3	4	5
	0	2	6	12	20

$$U_n = an^2 + bn + c$$

(b) Find an expression, in terms of n , for the n th term of this sequence.

$$n=1 \quad U_1 = 0$$

$$(a \times 1^2) + (b \times 1) + c = 0$$

$$a + b + c = 0 \quad \textcircled{1}$$

$$(a \times 2^2) + (b \times 2) + c = 2$$

$$4a + 2b + c = 2 \quad \textcircled{2}$$

$$(a \times 3^2) + (b \times 3) + c = 6$$

$$9a + 3b + c = 6 \quad \textcircled{3}$$

$$\textcircled{2} - \textcircled{1} \Rightarrow 3a + b = 2 \quad \textcircled{4}$$

$$\textcircled{3} - \textcircled{1} \Rightarrow 8a + 2b = 6 \quad \textcircled{5}$$

$$\begin{array}{r} - 8a + 2b = 6 \\ - 6a + 2b = 4 \\ \hline \end{array}$$

$$2a = 2$$

$$a = 1$$

$$\textcircled{4} (3 \times 1) + b = 2$$

$$b = -1$$

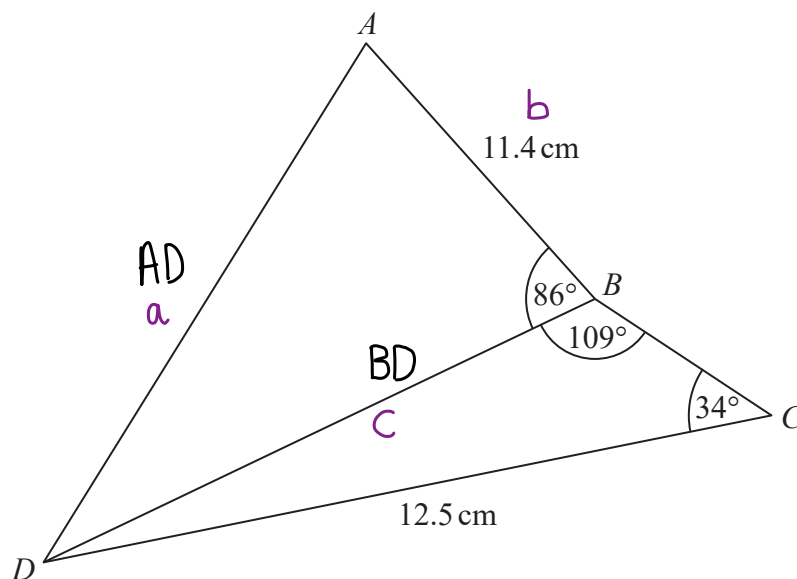
$$\begin{array}{l} a + b + c = 0 \\ 1 - 1 + c = 0 \\ c = 0 \end{array}$$

$$\frac{n^2 - n}{(2)}$$

(Total for Question 16 is 6 marks)



17



Work out the **length** of **AD**.

Give your answer correct to **3 significant figures**.

Finding BD from triangle BCD:

2 angles, 2 sides

Sine Rule $\frac{a}{\sin A} = \frac{b}{\sin B}$

$$\frac{BD}{\sin(34)} = \frac{12.5}{\sin(109)} \quad (1)$$

$$BD = \frac{12.5}{\sin(109)} \times \sin(34)$$

$$BD = 7.39... \quad (1)$$

(use the exact value in the rest of the question)

Finding AD from triangle ABD:

3 sides, 1 angle

Cosine Rule $a^2 = b^2 + c^2 - 2bc \cos(A)$

$$(AD)^2 = (AB)^2 + (BD)^2 - (2 \times (AB) \times (BD) \times \cos(86))$$

$$(AD)^2 = (11.4^2 + (7.39...)^2) - (2 \times 11.4 \times 7.39... \times \cos(86)) \quad (1)$$

$$(AD)^2 = 172.85... \quad (1)$$

$$AD = \sqrt{172.85}$$

$$AD = 13.147 = 13.1 \text{ to 3SF}$$

..... 13.1 cm

(Total for Question 17 is 5 marks)



18 (a) Show that the equation $x^3 + x = 7$ has a solution between 1 and 2

$$x^3 + x = 7$$

an x value between 1 and 2
Satisfies this equation

$$x^3 + x - 7 = 0 \quad \text{let } y = x^3 + x - 7$$

When $x = 1$ $y = 1^3 + 1 - 7 = 1 + 1 - 7 = -5$
 $x = 2$ $y = 2^3 + 2 - 7 = 8 + 2 - 7 = 3$ ①

There is a change in sign (-5 to 3) so there must be a solution between 1 and 2 ① (2)

(b) Show that the equation $x^3 + x = 7$ can be rearranged to give $x = \sqrt[3]{7-x}$

$$x^3 + x = 7$$

$$x^3 = 7 - x$$

$$\sqrt[3]{x^3} = \sqrt[3]{7-x}$$

$$x = \sqrt[3]{7-x} \quad \text{①}$$

(1)

(c) Starting with $x_0 = 2$, use the iteration formula $x_{n+1} = \sqrt[3]{7-x_n}$ three times to find an estimate for a solution of $x^3 + x = 7$

$$x_1 = \sqrt[3]{7-x_0}$$

$$x_1 = \sqrt[3]{7-2} = \sqrt[3]{5} = 1.70997... \quad \text{①}$$

$$x_2 = \sqrt[3]{7-x_1}$$

$$x_2 = \sqrt[3]{7-1.70997...} = 1.74241... \quad \text{①}$$

$$x_3 = \sqrt[3]{7-x_2}$$

$$x_3 = \sqrt[3]{7-1.74241...} = 1.73884... \\ = 1.74$$

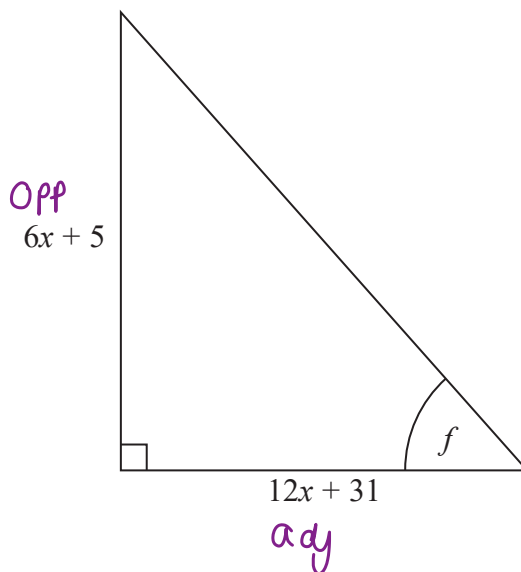
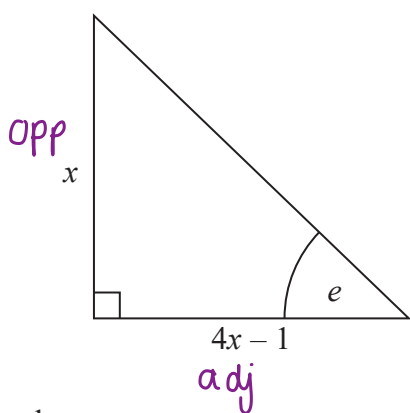
Use the exact values stored in your calculator to make sure there is no error in further iterations due to rounding.

1.74 ①
.....
(3)

(Total for Question 18 is 6 marks)



19 Here are two right-angled triangles.



Given that

$\tan e = \tan f$

SOH CAH TOA

find the value of x .

$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$

You must show all your working.

$\tan e = \frac{x}{4x-1}$ $\tan f = \frac{6x+5}{12x+31}$

Cross multiply
 $\frac{x}{4x-1} = \frac{6x+5}{12x+31}$ ①

Multiply out
 $x(12x+31) = (6x+5)(4x-1)$ ①

$12x^2 + 31x = 24x^2 - 6x + 20x - 5$

$12x^2 + 31x = 24x^2 + 14x - 5$

$0 = (24x^2 - 12x^2) + (14x - 31x) - 5$ $-(12x^2 + 31x)$

$0 = 12x^2 - 17x - 5$ ①

Solving for x :

(By factorisation or using the quadratic formula)

$(4x+1)(3x-5) = 0$ ①

\therefore either $4x+1=0$ or $3x-5=0$

$4x = -1$
 $x = -\frac{1}{4}$

$3x = 5$
 $x = \frac{5}{3}$

$\frac{5}{3}$ ①

$x > 0$ as it is a length \therefore solution is not valid

(Total for Question 19 is 5 marks)

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20 50 people were asked if they speak French or German or Spanish.

Of these people,

- ⑥ 31 speak French
- ① 2 speak French, German and Spanish
- ② 4 speak French and Spanish but not German
- ③ 7 speak German and Spanish
- ④ 8 do not speak any of the languages
- ⑤ all 10 people who speak German speak at least one other language

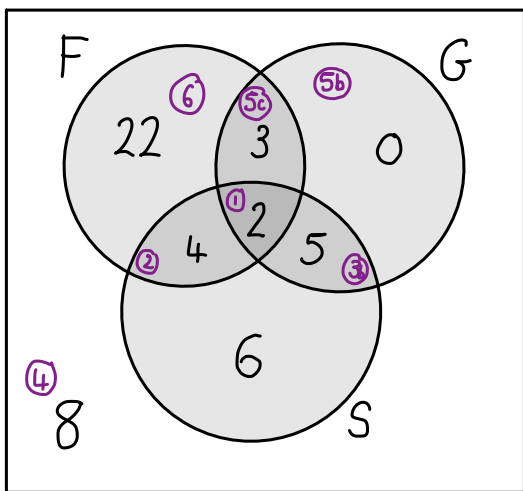
Use this point last

(need more values in the venn diagram for it to be useful)

Work through these in order adding values to the venn diagram

Two of the 50 people are chosen at random.

Work out the probability that they both only speak Spanish.



① Venn diagram with 1 unknown

③ 7 speak G and S

$7 - 2 = 5$ 5 speak G and S but not F

③b

① Finding 3 unknowns

⑤ 10 speak G

0 speak only G ⑤b

⑤c $10 - 2 - 5 = 3$

⑥ only F = $31 - 3 - 2 - 4 = 22$

Only S = Total - all already in venn diagram
 $= 50 - 22 - 3 - 2 - 4 - 5 - 8 = 6$ ①

Probability the first random person only speaks Spanish:

$$\frac{6}{50}$$

Probability the second person does (the first cannot be chosen again)

(Total for Question 20 is 5 marks)

$$\frac{6-1}{50-1} = \frac{5}{49}$$

Probability of both

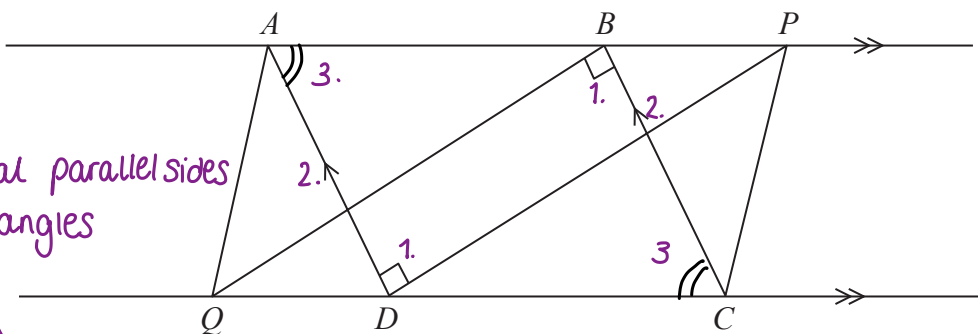
$$= \frac{6}{50} \times \frac{5}{49} \text{ ①}$$

$$= \frac{6}{490}$$

$$\frac{6}{490} \text{ ①}$$



21



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2 pairs of equal parallel sides and equal angles

$ABCD$ is a parallelogram.
 ABP and QDC are straight lines.
 Angle $ADP = \text{angle } CBQ = 90^\circ$

Exactly the same (3 sides and 3 angles)
 • SSS, ASA, SAS (not AAA)

(a) Prove that triangle ADP is congruent to triangle CBQ .

1. angle $ADP = \text{angle } CBQ \Rightarrow \text{both are } 90^\circ$ (1) 1 statement and reasoning
2. $AB = BC$ as opposite sides of a parallelogram are equal
3. angle $PAD = \text{angle } QCB$ as opposite angles in a parallelogram are equal

(1) all 3 statements + reasoning

The two triangles are therefore congruent, by ASA (they have 2 angles and a side length in common)

(1) Conclusion with ASA
 (3)

(b) Explain why AQ is parallel to PC .

Considering $APCQ$:

from part a)

- $AP = QC$ since triangle ADP is congruent to triangle CBQ (1)
- AP and QC are parallel and equal
- Therefore $APCQ$ is a parallelogram
- opposite sides of a parallelogram are parallel

So therefore AQ is parallel to PC (1)

(2)

(Total for Question 21 is 5 marks)

TOTAL FOR PAPER IS 80 MARKS

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